

Hydrological Summary for Great Britain

JULY 1993

Rainfall

The failure of the high pressure cell over the Azores to follow its normal northerly migration during the summer has allowed low pressure systems to penetrate much of western Europe bringing persistently unsettled weather to many regions. July in Britain - despite a warm start - was another cool, cloudy month with weather conditions determined largely by a succession of Atlantic fronts carried on a westerly or south-westerly air flow. The provisional July rainfall total for Britain is around 130% of the 1961-90 average; in the last 30 years only July 1988 has been substantially wetter. Damp, overcast conditions typified much of the month and after the first week rainfall was registered on the majority of days - however in some districts the wet complexion to the weather failed to produce above average rainfall totals for the month. Regional rainfall totals were close to, or above, average and the normal west-to-east rainfall gradient was clearly accentuated; parts of Wales and the South-West received more than twice the July average. The generally unsettled conditions since the late spring are reflected in the April-July rainfall totals which are typically 20-50% above average. The South West has been extremely wet with many catchments registering unprecedented rainfall totals in this timeframe. For the year thus far, regional rainfall totals in England and Wales have been close to normal and are mostly well above average over the last twelve months. Relatively wet conditions, albeit with dry interludes, since the spring of 1992 have reduced the long term rainfall deficiencies - at the regional scale - to modest magnitudes. In Scotland, by contrast, the wet phase continues and the long term rainfall accumulations are very remarkable. The 60-month totals for Scotland ending in the summer of 1993 are the highest in a record from 1869. Table 2 confirms that these truly exceptional wet conditions have mainly characterised western Scotland and the Highlands.

River Flow

Generally, soils dried-out briskly over the three-week period beginning around June 19th; this reduced the hydrological effectiveness of the July rainfall in many areas. Apart from some western catchments, July

mean flows were appreciably below those for June but mostly well within the normal summer range. Exceptions could be found along the western seaboard where, for instance, the Ewe (Highland Region) and Kenwyn (Cornwall) established new maximum July runoff totals - and in parts of East Anglia where flows remain on the low side of normal. In contrast to June, flooding was restricted to a few local events mostly associated with thundery activity on active frontal systems; Lincoln, for example, was badly affected on the 15th. Although commonly close to - or below - average, July runoff totals throughout most of the English lowlands were, typically, the highest since 1988. Over the longest timespans runoff accumulations remain depressed in parts of eastern England but the spring and summer totals for 1993 substantially exceed those for the recent drought years.

Groundwater

Groundwater levels followed a characteristically gentle summer recession in almost all areas during July although a few relatively steep declines occurred in some fissured aquifers. Recharge patterns in 1993 have been somewhat erratic in both spatial and temporal terms but by late July/early August most index wells showed levels close to their long term late summer average. A year ago levels in the eastern Chalk were (probably) at their lowest since the turn of the century - the subsequent recovery, although uneven, has been notable, increasing levels to their highest for the late summer in five or six years. Some depressed water-tables remain in parts of the Permo-Triassic sandstones but the impact of late spring/early summer infiltration may be recognised at a number of sites, in the South-West particularly.

General

Reservoir stocks are healthy in all regions. Soils are significantly moister than in the extended summers of the 1988-91 period and, given around average rainfall, a normal seasonal recovery in runoff and recharge rates may be anticipated. The water resources outlook is good.



Institute of
Hydrology

This document is copyright and may not be reproduced without prior permission of the Natural Environment Research Council



British
Geological
Survey

Data for this report have been provided principally by the regional divisions of the National Rivers Authority* in England and Wales, the River Purification Boards in Scotland and by the Meteorological Office. Reservoir contents information has been supplied by the Water Services Companies, the NRA or, in Scotland, the Lothians Regional Council. The most recent areal rainfall figures are derived from a restricted network of raingauges (particularly in Scotland) and a proportion of the river flow data is of a provisional nature.

A map (Figure 3) is provided to assist in the location of the principal monitoring sites.

* For reasons of consistency the original ten regional divisions of the NRA have been retained for use in the Hydrological Summaries.

13 August 1993

© Natural Environment Research Council 1993

Institute of Hydrology/British Geological Survey
Maclean Building
Crowmarsh Gifford
Wallingford
Oxfordshire
OX10 8BB

TABLE 1 1992/93 RAINFALL AS A PERCENTAGE OF THE 1961-90 AVERAGE*

		July	Aug	Sept	Oct	Nov	Dec	Jan 1993	Feb	Mar	Apr	May	Jun	Jul
England and Wales	mm	83	129	92	84	138	83	98	15	27	96	86	77	83
	%	134	170	119	99	153	88	111	24	38	160	135	119	134
NRA REGIONS														
North West	mm	79	151	110	121	172	118	152	22	32	116	131	62	101
	%	93	141	96	95	140	95	126	28	34	163	175	77	119
Northumbria	mm	63	99	95	81	100	71	108	17	28	120	118	46	65
	%	97	122	130	107	116	88	129	29	40	214	190	76	99
Severn-Trent	mm	88	120	74	71	113	61	81	10	15	78	84	64	76
	%	166	179	116	111	159	79	116	19	25	142	142	108	144
Yorkshire	mm	81	99	95	77	102	71	84	22	14	102	82	53	72
	%	137	134	140	105	128	86	106	38	21	173	137	88	123
Anglian	mm	89	83	86	73	83	41	57	17	17	71	52	52	68
	%	182	151	176	143	143	75	114	46	36	154	108	101	139
Thames	mm	78	107	93	73	117	58	85	6	23	83	61	54	58
	%	159	184	158	118	180	83	133	13	41	166	109	99	118
Southern	mm	75	104	70	86	141	76	94	9	30	91	58	56	56
	%	156	182	101	108	166	93	118	17	48	172	107	104	116
Wessex	mm	64	129	85	52	152	86	117	7	43	82	62	69	74
	%	123	195	118	66	183	92	134	11	61	155	102	121	143
South West	mm	83	174	93	96	216	122	171	22	33	98	131	127	129
	%	120	207	100	83	173	88	124	22	33	142	182	183	188
Welsh	mm	93	222	114	102	214	145	197	23	34	107	124	104	108
	%	121	220	99	74	151	95	138	24	32	134	151	131	140
Scotland	mm	91	221	177	123	212	159	291	67	91	128	132	101	127
	%	97	189	125	79	140	105	193	66	73	168	154	118	135
RIVER PURIFICATION BOARDS														
Highland	mm	95	255	214	155	280	239	358	86	151	86	93	123	122
	%	90	201	125	78	138	121	190	68	93	95	101	125	115
North-East	mm	47	132	107	110	93	78	152	41	55	68	109	69	90
	%	64	152	123	113	94	84	154	63	71	113	158	105	123
Tay	mm	77	201	160	70	163	113	319	32	113	135	132	83	94
	%	100	214	140	54	135	89	222	34	104	218	159	114	122
Forth	mm	74	183	166	66	153	84	247	42	188	108	119	86	81
	%	99	195	151	57	137	76	209	53	194	183	161	125	107
Tweed	mm	61	157	118	77	135	82	158	21	41	124	130	64	66
	%	84	178	133	81	145	88	158	31	52	218	183	99	91
Solway	mm	101	215	155	116	203	133	207	13	103	163	139	74	96
	%	112	181	108	74	141	90	133	13	88	212	164	88	107
Clyde	mm	123	278	205	133	255	165	339	18	161	158	119	94	107
	%	113	207	115	69	142	92	179	15	110	188	131	101	98

* The change from using the 1941-70 based period has resulted in a number of mostly minor changes in the percentage rainfall figures for the pre-July 1993 period.

Note: The most recent monthly rainfall figures correspond to the MORECS areal assessments derived by the Meteorological Office; the provisional figures for England and Wales and for Scotland are derived using a different raingauge network. Regional areal rainfall figures are regularly updated (normally one or two months in arrears) using figures derived from a far denser raingauge network.

TABLE 2 RAINFALL RETURN PERIOD ESTIMATES

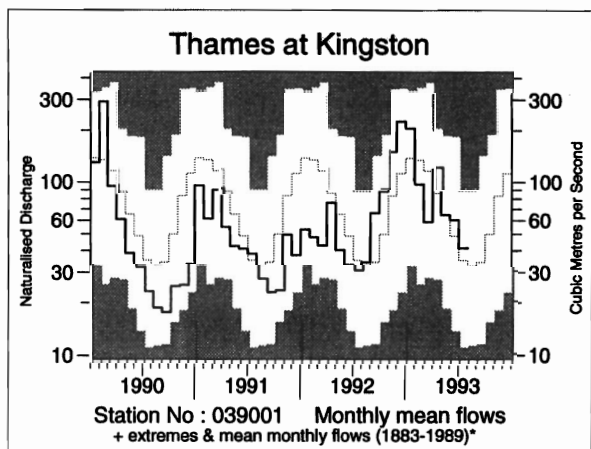
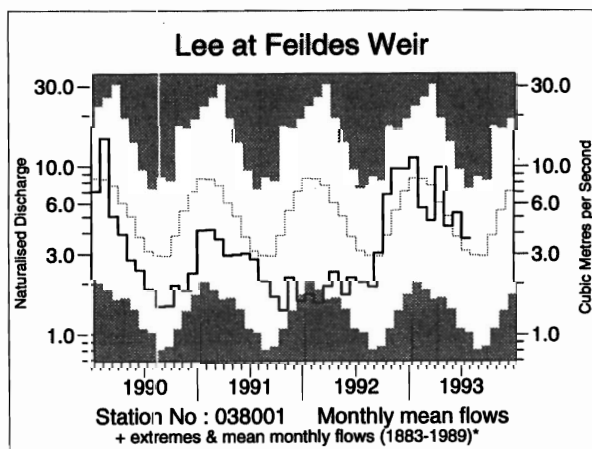
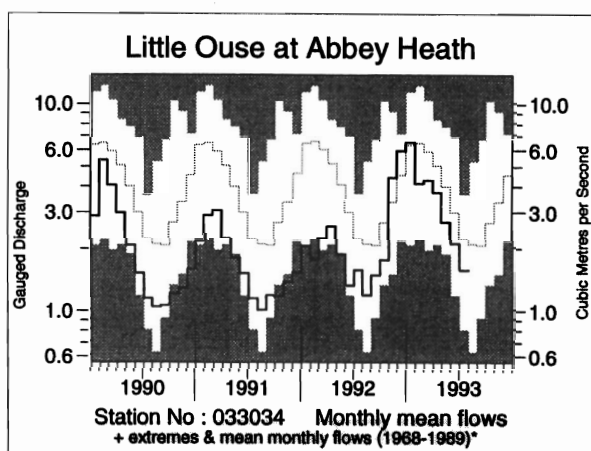
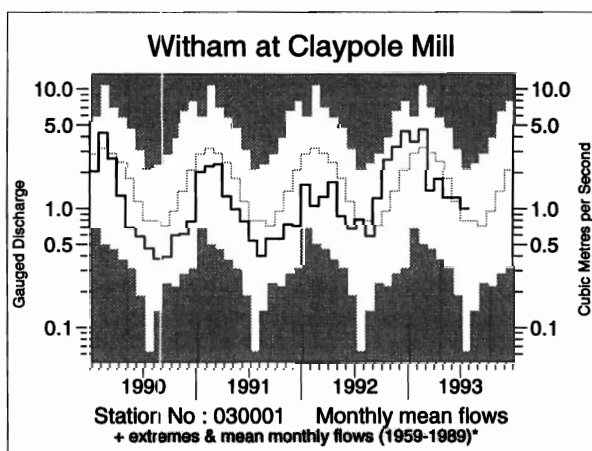
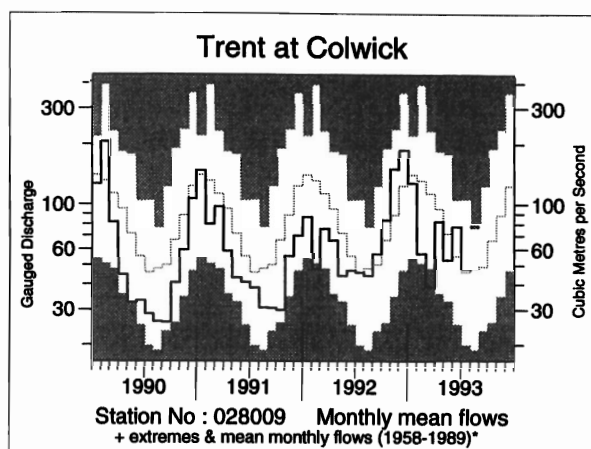
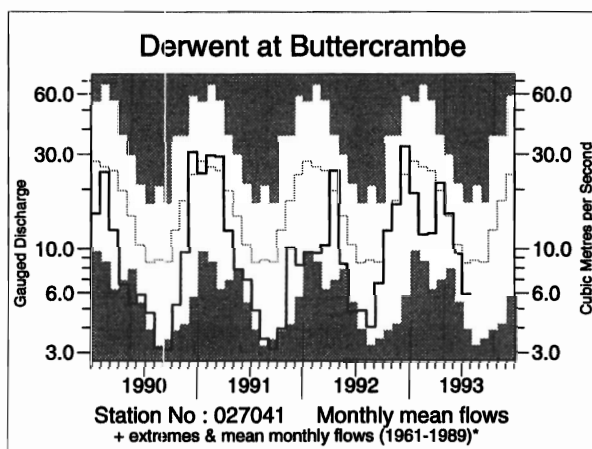
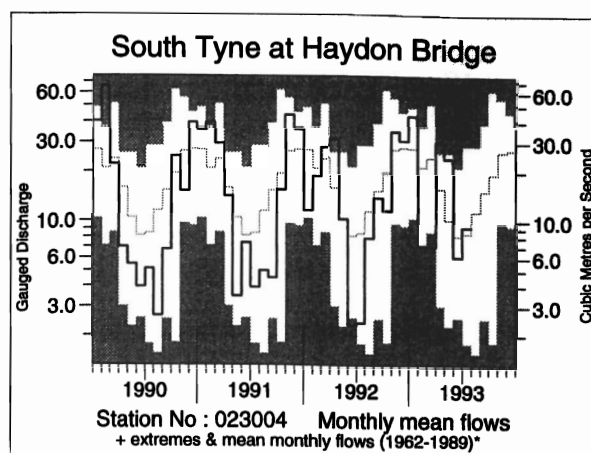
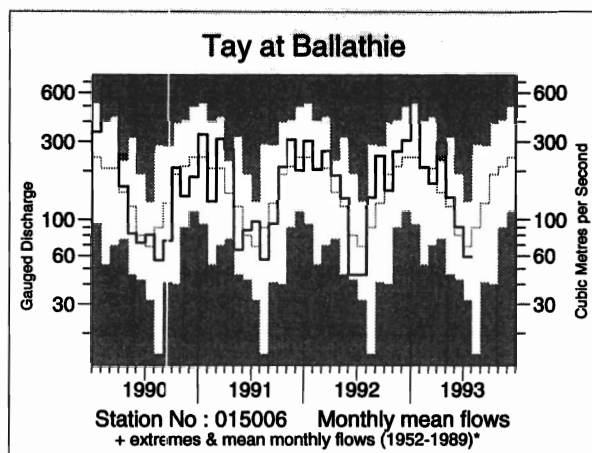
		Apr93-Jul93		Aug92-Jul93		Mar90-Jul93		Aug88-Jul93	
		Est Return Period, years		Est Return Period, years		Est Return Period, years		Est Return Period, years	
England and Wales	mm % LTA	342 136	<u>10-20</u>	1008 113	<u>5-10</u>	2784 93	5-10	4206 94	5-10
NRA REGIONS									
North West	mm % LTA	410 131	<u>10-20</u>	1288 107	<u>2-5</u>	3831 95	2-5	5857 97	2-5
Northumbria	mm % LTA	348 143	<u>20-40</u>	947 111	<u>2-5</u>	2772 97	2-5	3988 94	5-10
Severn-Trent	mm % LTA	302 134	<u>10-20</u>	847 112	<u>5-10</u>	2373 93	5-10	3562 95	2-5
Yorkshire	mm % LTA	309 130	<u>5-10</u>	873 106	<u>2-5</u>	2487 90	10-20	3713 90	10-20
Anglian	mm % LTA	243 125	<u>5-10</u>	700 117	<u>5-10</u>	1854 91	5-10	2711 91	10-20
Thames	mm % LTA	256 122	<u>5</u>	818 119	<u>5-10</u>	2114 91	5-10	3174 92	5-10
Southern	mm % LTA	261 125	<u>5-10</u>	871 112	<u>2-5</u>	2340 90	5-10	3491 90	10-20
Wessex	mm % LTA	288 129	<u>5-10</u>	959 114	<u>5-10</u>	2530 90	5-10	3907 93	5-10
South West	mm % LTA	485 174	<u>>100</u>	1412 120	<u>10-20</u>	3670 94	2-5	5675 97	2-5
Welsh	mm % LTA	442 139	<u>10-20</u>	1493 114	<u>5-10</u>	4148 95	2-5	6405 98	2-5
Scotland	mm % LTA	488 143	<u>60-100</u>	1829 127	<u>100-200</u>	5515 115	<u>100-200</u>	8295 116	<u>> >200</u>
RIVER PURIFICATION BOARDS									
Highland	mm % LTA	423 109	<u>2-5</u>	2161 123	<u>30-50</u>	6808 117	<u>>200</u>	10344 118	<u>> >200</u>
North-East	mm % LTA	336 125	<u>5-10</u>	1104 114	<u>5-10</u>	3294 101	<u>2-5</u>	4745 98	<u>2-5</u>
Tay	mm % LTA	434 151	<u>50-80</u>	1615 131	<u>60-100</u>	4536 111	<u>10-20</u>	6900 112	<u>30-50</u>
Forth	mm % LTA	394 142	<u>30-50</u>	1423 128	<u>60-90</u>	4104 111	<u>10-20</u>	6141 111	<u>20-40</u>
Tweed	mm % LTA	384 145	<u>30-50</u>	1173 121	<u>10-20</u>	3427 105	<u>2-5</u>	4948 102	<u>2-5</u>
Solway	mm % LTA	472 140	<u>20-50</u>	1617 114	<u>5-10</u>	4969 105	<u>2-5</u>	7548 106	<u>5-10</u>
Clyde	mm % LTA	448 127	<u>10-20</u>	2032 120	<u>10-20</u>	6564 117	<u>100-200</u>	9934 117	<u>> >200</u>

LTA refers to the period 1961-90.

Return period assessments are based on tables provided by the Meteorological Office*. The tables reflect rainfall totals over the period 1911-70 only and the estimate assumes a sensibly stable climate. They assume a start in a specified month; return periods for a start in any month may be expected to be an order of magnitude less - for the longest durations the return period estimates converge. "Wet" return periods underlined.

* Tabony, R.C., 1977, The Variability of long duration rainfall over Great Britain, Scientific Paper No. 37, Meteorological Office.

FIGURE 1 MONTHLY RIVER FLOW HYDROGRAPHS



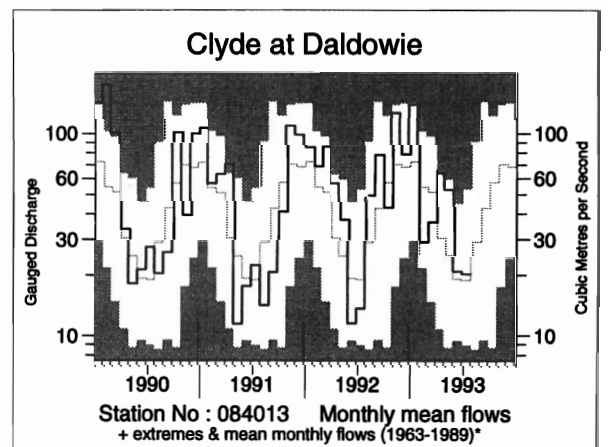
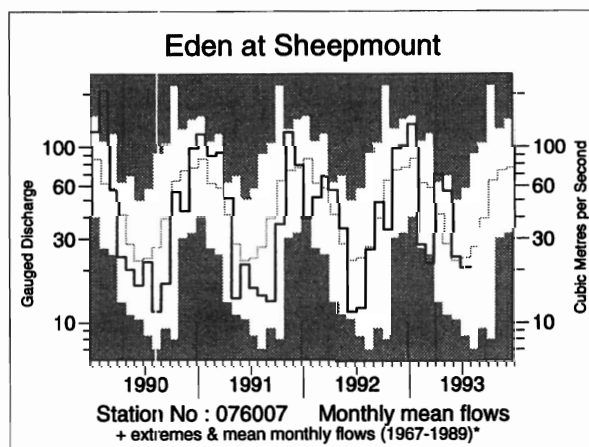
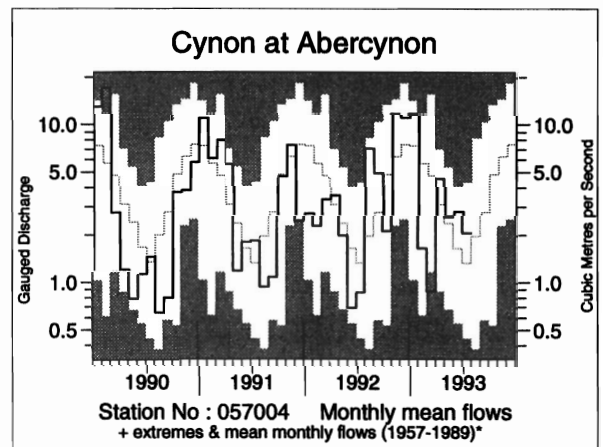
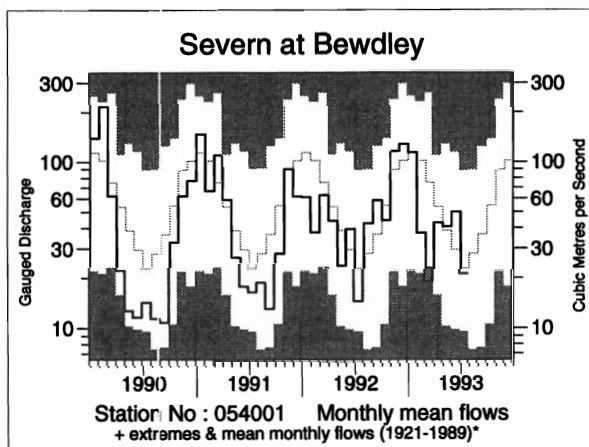
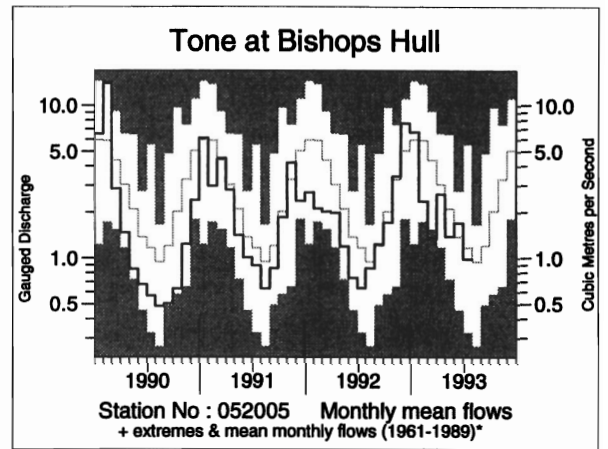
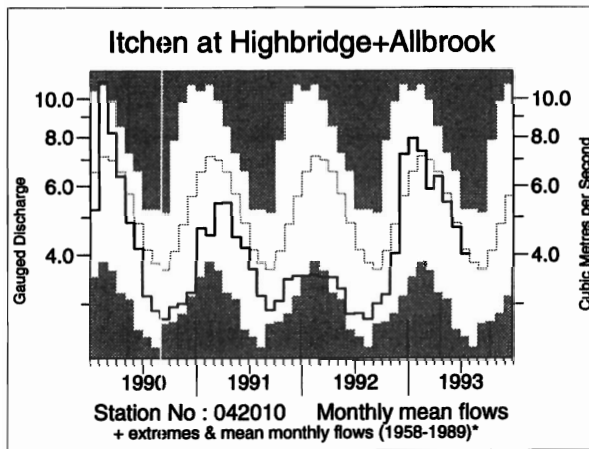
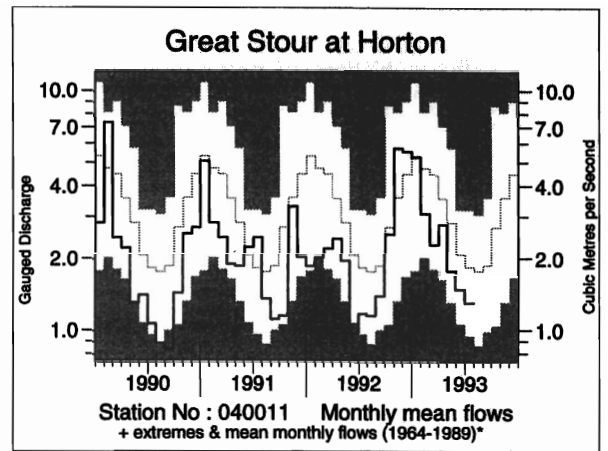
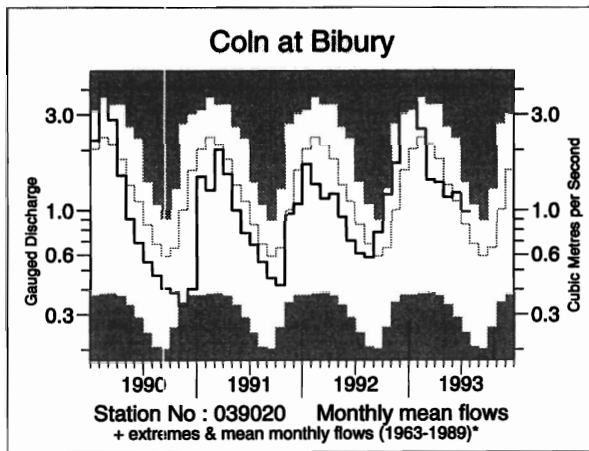


TABLE 3 RUNOFF AS MM. AND AS A PERCENTAGE OF THE PERIOD OF RECORD AVERAGE WITH SELECTED PERIODS RANKED IN THE RECORD

River/ Station name	Mar	Apr	May	Jun	Jul		5/93 to 7/93		1/93 to 7/93		5/90 to 7/93		11/88 to 7/93	
	1993				1993									
	mm %LT	mm %LT	mm %LT	mm %LT	mm %LT	rank /yrs	mm %LT	rank /yrs	mm %LT	rank /yrs	mm %LT	rank /yrs	mm %LT	rank /yrs
Dee at Park	66 71	97 124	87 142	33 90	23 82	11 /21	143 113	14 /21	535 116	18 /21	2318 92	6 /18	3352 87	2 /17
Tay at Ballathie	97 76	168 196	80 112	50 112	34 85	16 /41	164 107	28 /41	867 137	40 /41	3936 111	30 /38	6342 117	36 /37
Whiteadder Water at Hutton Castle	14 28	50 131	63 241	22 132	11 88	13 /24	96 169	23 /24	233 94	9 /24	1166 94	8 /21	1511 78	5 /20
Wharfe at Flint Mill Weir	20 26	60 110	63 169	27 110	27 103	20 /38	116 131	30 /38	355 91	15 /38	1960 87	5 /35	2994 86	2 /34
Derwent at Buttercrambe	20 49	35 112	25 107	15 91	10 72	10 /32	51 95	17 /32	156 75	8 /32	747 72	3 /29	1050 65	1 /28
Trent at Colwick	14 35	29 91	19 77	27 144	17 107	26 /35	63 105	22 /35	169 76	3 /35	872 78	3 /32	1367 79	2 /31
Witham at Claypole Mill	13 51	15 73	11 72	11 115	9 129	28 /35	31 97	21 /35	128 99	18 /34	460 79	8 /32	688 76	4 /30
Little Ouse at Abbey Heath	16 75	14 79	10 70	8 77	6 74	7 /26	24 74	7 /26	94 81	7 /25	318 60	2 /23	530 65	1 /21
Colne at Lexden	8 45	11 85	6 70	6 113	3 72	11 /34	15 84	12 /34	71 80	9 /34	287 69	3 /31	484 74	1 /30
Lee at Feildes Weir (natr.)	12 62	25 168	11 86	13 138	10 124	81 /108	34 112	73 /108	113 107	65 /107	349 68	9 /102	581 74	10 /99
Thames at Kingston (natr.)	16 52	31 138	17 98	16 127	11 116	77 /111	44 112	78 /111	170 104	61 /111	616 79	21 /108	979 82	13 /106
Coln at Bibury	36 68	34 80	29 89	30 115	25 121	22 /30	84 106	19 /30	298 107	16 /30	1082 86	8 /27	1652 86	4 /26
Itchen at Highbridge + Allbrook	44 86	46 100	41 98	34 100	30 100	19 /35	105 99	16 /35	302 101	17 /35	1172 79	2 /32	1773 80	1 /31
Piddle at Baggs Mill	35 63	38 90	29 92	23 100	18 101	14 /30	71 98	15 /30	284 102	16 /29	1060 83	6 /24	1625 82	3 /21
Exe at Thorverton	17 20	51 91	26 70	36 154	26 125	31 /38	88 108	25 /38	411 90	9 /37	2241 88	7 /35	3425 86	2 /33
Taw at Umbreleigh	11 16	35 80	27 93	73 471	32 211	32 /35	133 215	33 /35	341 92	12 /35	1845 87	7 /32	2912 88	2 /31
Tone at Bishops Hull	18 32	34 89	19 71	22 128	13 86	21 /33	54 91	18 /33	224 74	5 /32	1057 72	1 /30	1803 77	1 /28
Severn at Bewdley	12 26	26 82	25 107	30 172	13 93	46 /73	68 124	61 /73	197 76	11 /72	1148 82	8 /70	1846 85	4 /68
Yscir at Pontaryscir	17 15	64 105	41 99	54 188	34 156	20 /22	130 138	19 /22	444 87	5 /21	2827 94	6 /18	4446 93	4 /16
Dee at Manley Hall	28 31	73 117	69 152	59 168	30 88	31 /56	158 137	48 /56	440 87	14 /56	2698 90	10 /53	4254 92	9 /52
Eden at Sheepmount	26 37	79 168	66 205	27 109	24 91	14 /23	117 139	21 /23	409 108	15 /23	2171 102	9 /17	3350 102	7 /14
Clyde at Daldowie	52 68	89 199	76 218	29 111	29 107	21 /30	133 149	29 /30	508 128	29 /30	2902 120	26 /27	4367 119	26 /26
Carron at New Kelso	255 90	94 67	61 61	85 117	229 198	15 /15	375 128	13 /15	1471 118	12 /15	8749 108	11 /12	13920 114	10 /10

Notes: (i) Values based on gauged flow data unless flagged (natr.), when naturalised data have been used.
(ii) Values are ranked so that lowest runoff as rank 1.
(iii) %LT means percentage of long term average from the start of the record to 1992. For the long periods (at the right of this table), the end date for the long term is 1993.

TABLE 4 START-MONTH RESERVOIR STORAGES UP TO JULY 1993

Area	Reservoir (R)/ Group (G)	Capacity● (MI)	1993							1992
			Mar	Apr	May	June	July	Aug	Aug	
North West	Northern Command Zone ¹	(G)	133375	84	77	91	92	77	66	55
	Vyrnwy	(R)	55146	87	78	87	94	89	81	80
Northumbria	Teesdale ²	(G)	87936	91	83	95	96	80	72	58
	Kielder	(R)	199175*	81*	81*	91*	96*	91*	90*	77*
Severn-Trent	Clywedog	(R)	44922	87	87	95	100	96	94	85
	Derwent Valley ³	(G)	39525	91	73	81	72	76	77	73
Yorkshire	Washburn ⁴	(G)	22035	92	83	91	94	81	72	72
	Bradford supply ⁵	(G)	41407	89	76	83	91	80	74	58
Anglian	Grafham	(R)	58707	93	92	93	95	95	96	95
	Rutland	(R)	130061	93	88	94	93	96	93	81
Thames	London ⁶	(G)	206232	93	91	95	96	94	96	85
	Farmoor ⁷	(G)	13843	96	95	99	98	98	98	97
Southern	Bowl	(R)	28170	91	91	97	96	91	85	64
	Ardingly	(R)	4685	100	100	100	100	99	90	88
Wessex	Clatworthy	(R)	5364*	94	83	86	86	91	82	47
	Bristol WW ⁸	(G)	38666*	93*	85*	89*	84*	76*	67*	61*
South West	Colliford	(R)	28540	88	83	83	84	87	86	66
	Roadford	(R)	34500	83	80	78	78	82	81	75
	Wimbleball ⁹	(R)	21320	99	91	92	89	89	83	53
	Stithians	(R)	5205	98	88	83	91	99	91	54
Welsh	Celyn + Brenig	(G)	131155	96	90	95	99	100	98	87
	Brianne	(R)	62140	96	90	99	100	98	97	77
	Big Five ¹⁰	(G)	69762	91	78	89	92	89	86	66
	Elan Valley ¹¹	(G)	99106	88	89	98	100	97	96	87
Lothian	Edinburgh/Mid Lothian	(G)	97639	95	93	99	99	96	89	79
	West Lothian	(G)	5613	91	92	100	99	99	89	49
	East Lothian	(G)	10206	99	97	100	100	99	92	72

● Live or usable capacity (unless indicated otherwise)

* Gross storage/percentage of gross storage

1. Includes Haweswater, Thirlmere, Stocks and Barnacre.
2. Cow Green, Selset, Grassholme, Balderhead, Blackton and Hury.
3. Howden, Derwent and Ladybower.
4. Swinsty, Fewston, Thruscross and Eccup.
5. The Nidd/Barden group (Scar House, Angram, Upper Barden, Lower Barden and Chelker) plus Grimwith.
6. Lower Thames (includes Queen Mother, Wraysbury, Queen Mary, King George VI and Queen Elizabeth II) and Lee Valley (includes King George and William Girling) groups - pumped storages.
7. Farmoor 1 and 2 - pumped storages.
8. Blagdon, Chew Valley and others.

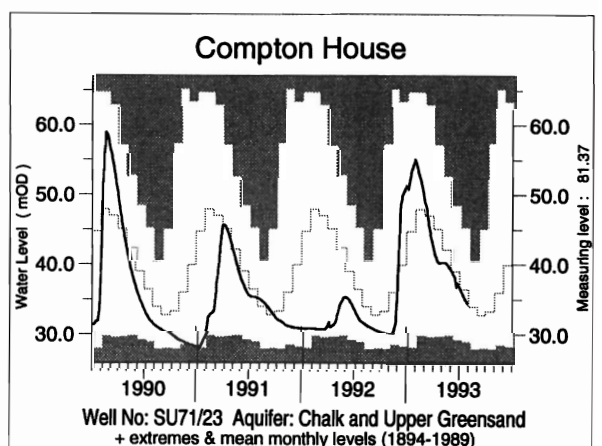
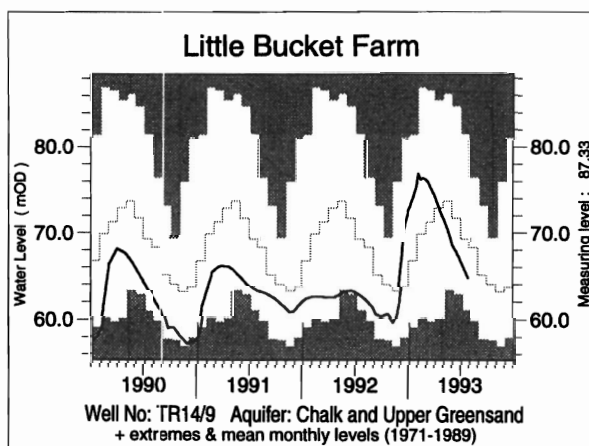
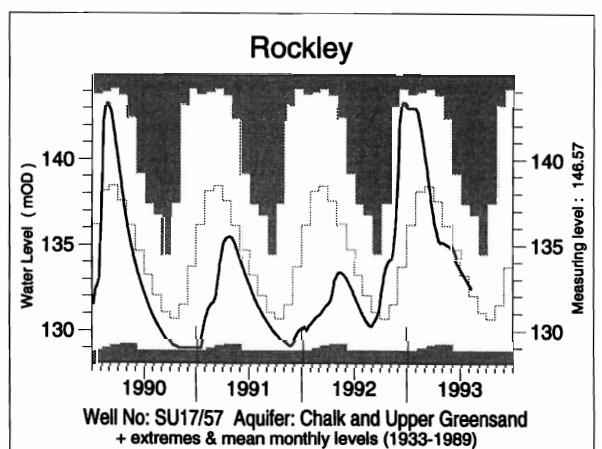
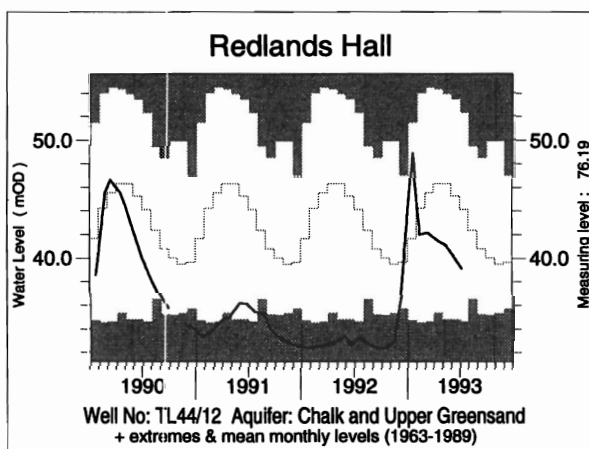
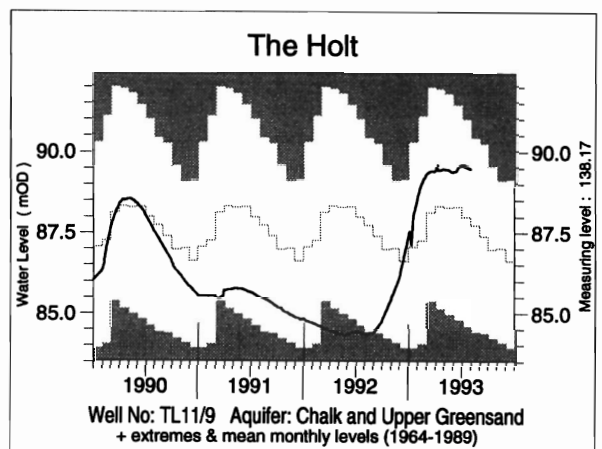
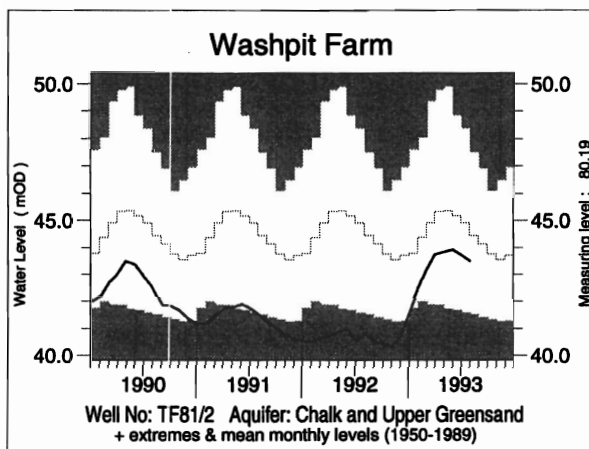
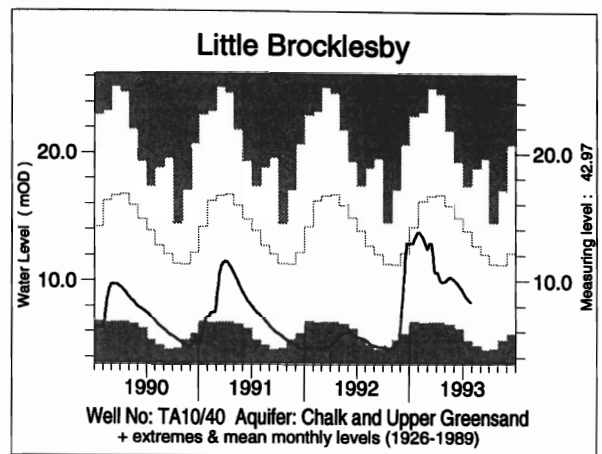
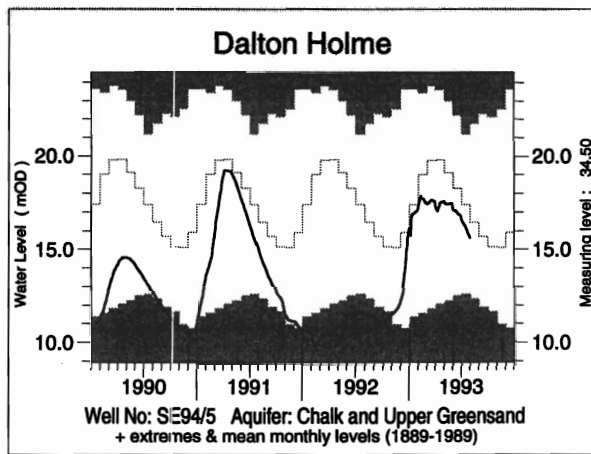
9. Shared between South West (river regulation for abstraction) and Wessex (direct supply).

10. Usk, Talybont, Llandegfedd (pumped storage), Taf Fechan, Taf Fawr.

11. Claerwen, Caban Coch, Pen y Garreg and Craig Goch.

Note: Variations in storage depend on the balance between inputs (from catchment rainfall and any pumping) and outputs (to supply, compensation flow, HEP, amenity). There will be additional losses due to evaporation, especially in the summer months. Operational strategies for making the most efficient use of water stocks will further affect reservoir storages. Table 4 provides a link between the hydrological conditions described elsewhere in the report and the water resources situation.

FIGURE 2 GROUNDWATER LEVEL HYDROGRAPHS



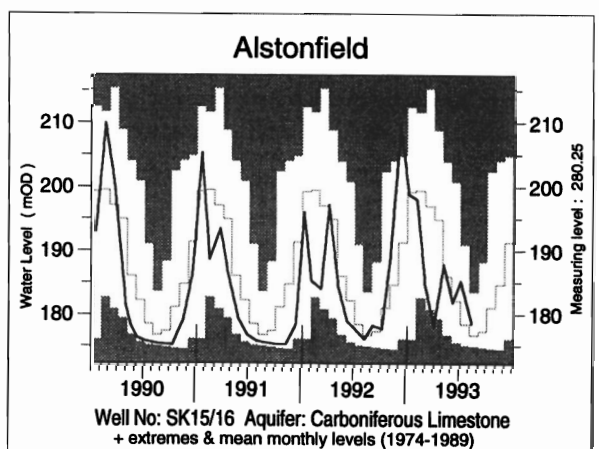
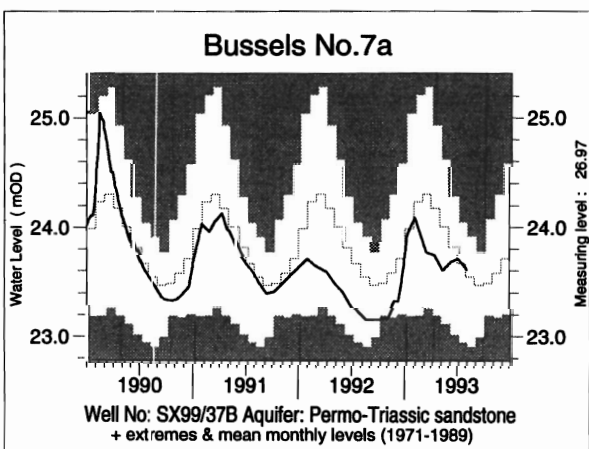
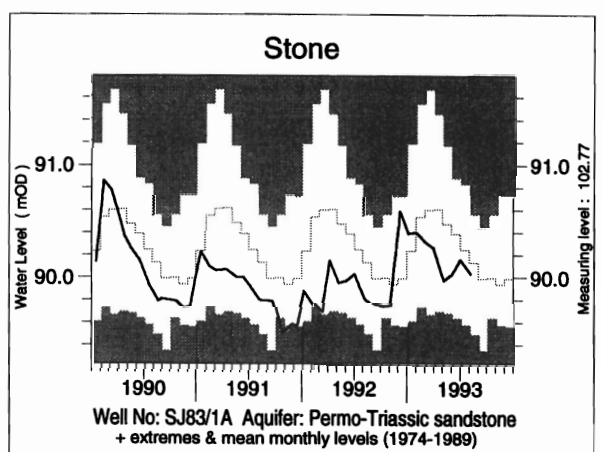
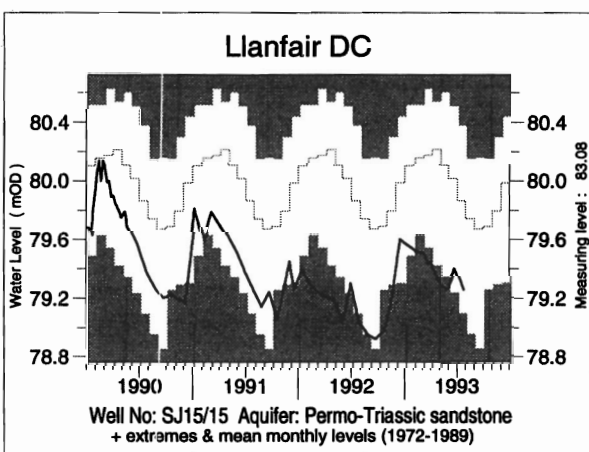
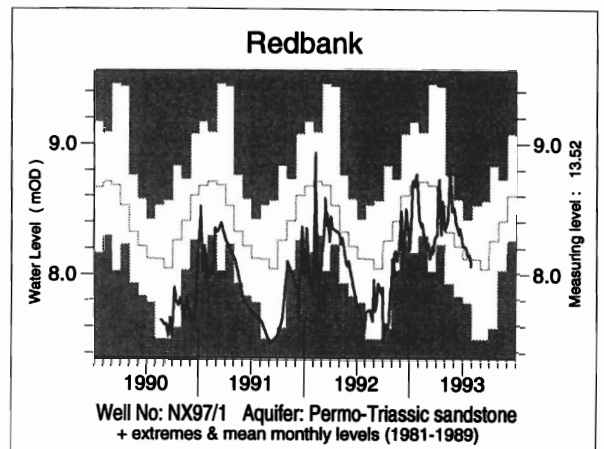
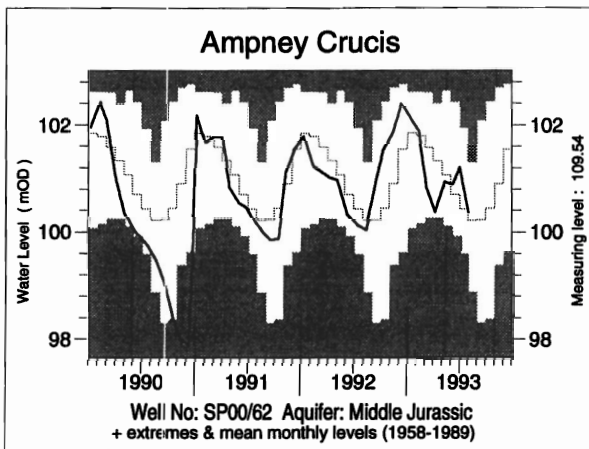
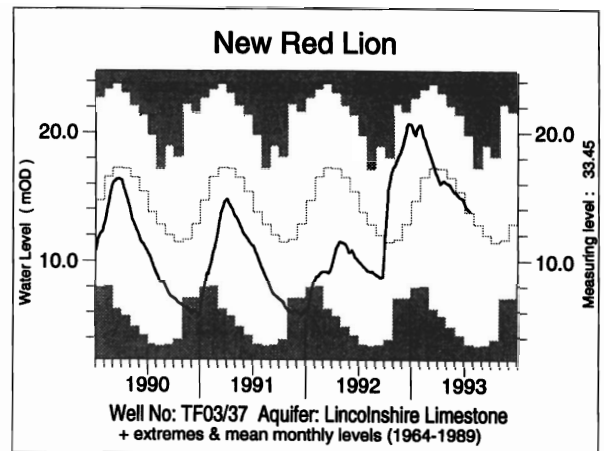
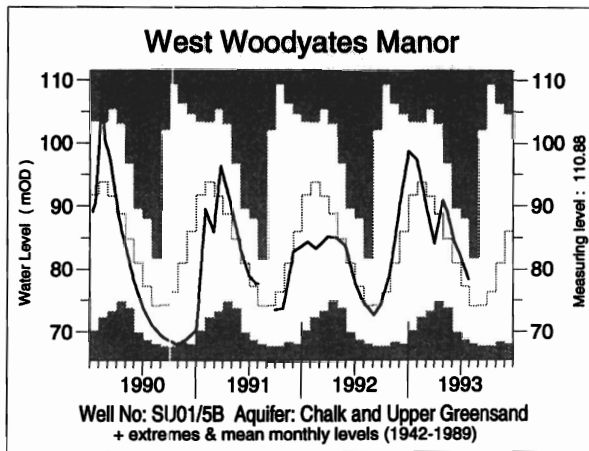


TABLE 5 A COMPARISON OF JULY GROUNDWATER LEVELS: 1992 AND 1993

Site	Aquifer	Records commence	Average July level	July 1992		July/Aug 1993		No. of years July level <1993	Lowest pre- 1993 level any month
				day	level	day	level		
Wetwang	C & UGS	1971	20.91	29/07	18.75	30/07	20.14	7	16.66
Dalton Holme	C & UGS	1889	17.39	30/07	11.51	30/07	15.65	>10	9.64
Little Brocklesby	C & UGS	1926	12.92	29/07	5.30	27/07	8.32	5	4.53
Washpit Farm	C & UGS	1950	44.77	01/07	40.51	02/08	43.49	8	40.30
The Holt	C & UGS	1964	87.88	01/07	84.40	01/08	89.48	>10	83.90
Therfield Rectory	C & UGS	1883	84.60	01/07	72.03	01/08	79.15	>10	dry <71.6
Redlands Hall	C & UGS	1964	43.03	17/07	33.28	09/07	39.08	7	32.29
Rockley	C & UGS	1933	133.17	26/07	131.12	09/08	132.46	>10	dry <128.9
Little Bucket Farm	C & UGS	1971	68.93	28/07	62.25	29/07	64.73	7	56.77
Compton House	C & UGS	1894	36.35	24/07	32.01	28/07	34.46	>10	27.64
Chilgrove House	C & UGS	1836	44.39	24/07	42.53	28/07	42.53	>10	33.46
West Dean No 3	C & UGS	1940	1.50	31/07	1.35	29/07	1.53	>10	1.01
Lime Kiln Way	C & UGS	1969	125.23	17/07	123.91	15/07	124.24	1	123.70
Ashton Farm	C & UGS	1974	67.74	01/07	66.60	28/07	66.02	6	63.10
West Woodyates	C & UGS	1942	76.97	27/07	74.90	28/07	78.38	>10	67.62
New Red Lion	LLst	1964	13.44	30/07	9.31	19/07	13.85	>10	3.29
Ampney Crucis	Mid Jur	1958	100.54	10/07	100.16	01/08	100.45	>10	97.38
Yew Tree Farm	PTS	1973	13.45	24/07	13.23	28/07	13.46	10	8.43
Llanfair DC	PTS	1972	79.79	19/07	79.04	19/07	79.25	2	78.85
Morris Dancers	PTS	1969	32.52	06/07	31.94	16/07	31.90	1	30.87
Stone	PTS	1974	90.27	03/07	90.03	06/08	90.03	6	89.34
Skirwith	PTS	1978	130.30	31/07	129.99	28/07	130.23	4	129.44
Redbank	PTS	1981	8.02	30/07	7.55	31/07	8.05	6	7.45
Bussels 7A	PTS	1972	23.66	15/07	23.23	04/08	23.61	10	22.90
Rushyford NE	MgLst	1967	76.15	31/07	74.61	07/07	75.62	>10	64.77
Peggy Ellerton	MgLst	1968	34.62	09/07	31.53	07/07	31.63	2	31.10
Alstonfield	CLst	1974	178.95	03/07	177.53	09/08	178.34	>10	174.22

groundwater levels are in metres above Ordnance Datum

C & UGS
LLst
PTS

Chalk and Upper Greensand
Lincolnshire Limestone
Permo-Triassic sandstones

Mid Jur
MgLst
CLst

Middle Jurassic limestones
Magnesian Limestone
Carboniferous Limestone

FIGURE 3 LOCATION MAP OF GAUGING STATIONS AND GROUNDWATER INDEX WELLS

